

PATENT COOPERATION TREATY

From the
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PCT

To:

see form PCT/ISA/220

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/IT2004/000380

International filing date (day/month/year)
09.07.2004

Priority date (day/month/year)
13.08.2003

International Patent Classification (IPC) or both national classification and IPC
G03H1/08

Applicant
CONSIGLIO NAZIONALE DELLE RICERCHE

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

10/566036

International application No.
PCT/IT2004/000380

IAP20 Rec'd PCT/PTO 25 JAN 2006

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ in written format
 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

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Box No. II Priority

1. ☒ The following document has not been furnished:

- ☒ copy of the earlier application whose priority has been claimed (Rule 43bis.1 and 66.7(a)).
- ☐ translation of the earlier application whose priority has been claimed (Rule 43bis.1 and 66.7(b)).

Consequently it has not been possible to consider the validity of the priority claim. This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43bis.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.
3. ☐ It has not been possible to consider the validity of the priority claim because a copy of the priority document was not available to the ISA at the time that the search was conducted (Rule 17.1). This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.
4. Additional observations, if necessary:

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-14
	No: Claims	
Inventive step (IS)	Yes: Claims	4,6,9-11
	No: Claims	1-3,5,7,8,12-14
Industrial applicability (IA)	Yes: Claims	1-14
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

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Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

**WRITTEN OPINION OF THE
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AUTHORITY (SEPARATE SHEET)**

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Re Item VIII

Certain observations on the international application

1. Certain claims do not meet the requirement of Article 6 PCT in that the subject matter for which protection is sought lacks clarity for the following reasons :-
 - 1.2 Claim 1 is unclear in that
 - * it is not commonly accepted in the art that the expression "sub-image" is an equivalent of the term "pixel" (see "corresponding to as many elementary sub-images or pixels");
 - * the formulation : "made of a number V_r of signal intensity values" convey the -misleading- impression that V_r relates to the gray levels (=intensity values) of the detector;
 - * it is not clear what limitation the first step imposes to the claim;
 - * it is not clear what is intended by the expression "hologram reconstruction in the complex plane";
 - * the expression "corresponding to as many pixels of sizes equal to the ones of the others" is confusing.
 - 1.3 In view of the above remarks, the present claim 1 has been interpreted as follows : the invention concerns a method for the reconstruction of holographic images in digital holography, the holographic images being detected and transformed in a digitized hologram by an image detection device, the digitized hologram being made of an array having a number V_r of elementary pixels, the sizes of which being equal to the sampling intervals of the image detection device, the method comprising a first step of digitally processing the digitized hologram array, and a second step of digitally reconstructing the complex object in an observation plane starting from the digitized hologram processed in the first step, the method being characterised in that the second step is carried out through a discrete Fresnel Transform applied on an array of V_e pixels having sizes equal to that of said elementary pixels, wherein said array of V_e pixels (50,51) includes said array of V_r pixels (51) and an integer number $p = V_e - V_r > 0$ of constant values (50) .
 - 1.4 Furthermore, it is clear from the description that the following features are essential to the definition of the invention:

- (1) ... the constant values "OS" are null values (see page 9, lines 2-4 in the description);
- (2) ...the number V_e of pixels is inversely proportional to the desired pixel size to be obtained for the reconstructed image (see title, page 1, lines 5-6, page 9, lines 26-29 and see also the solved problems on pages 2,3).

Since independent claim 1 does not contain these features the application does not meet the requirement of Article 6, PCT taken in combination with Rule 6.3(b) PCT, namely that any independent claim must contain all the technical features essential to the definition of the invention.

- 1.5 In claims 7 & 8, the term "square" may advantageously be substituted by the term "rectangular" (indeed, claim 7 makes it clear that the reconstruction pixel is not square).
2. In the description, the following passages should be checked : p.2, l.6,7; p.7, l.25; p.8, l.14; p.10, l.2; p.10, l.21 (the equation); p.12, l.2; p.13, l.12; and the references in Fig. 5.

Re Item VII

Certain defects in the international application

- 3.1 Independent claim is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate.
- 3.2 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
- 3.3 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in document D1 is not mentioned in the description, nor is this document identified therein.

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1.1 Reference is made to the following documents :

- D1: BERNHARDT M ET AL: "CODING AND BINARIZATION IN DIGITAL FRESNEL HOLOGRAPHY" OPTICS COMMUNICATIONS, NORTH-HOLLAND PUBLISHING CO. AMSTERDAM,, vol. 77, no. 1, 1 June 1990, p 4-8,
D2: KREIS T M ET AL: "METHODS OF DIGITAL HOLOGRAPHY: A COMPARISON" PROCEEDINGS OF THE SPIE, SPIE, BELLINGHAM, VA, US, vol. 3098, 1997, pages 224-233, ISSN: 0277-786X
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1.3 Negative statements : claims 1-3,5,7,8,12-14 do not involve an inventive step (Article 33(3) PCT).

2. Objections according to Article 33(3), PCT - Lack of an inventive step.

2.1 The document **D1** is regarded as being the closest prior art to the subject-matter of the claims, and discloses (the references in parentheses applying to this document): a method for reconstructing holographic images (cf. abstract) wherein an hologram is detected and digitized by an image detection device (cf. paragraph 2), thereby generating an array having V_r pixels. This array is further processed and a discrete Fresnel transform is applied on it to reconstruct the object (cf. paragraph 3).

D1 fails to teach that, prior to apply the Fresnel transform, the digitized hologram is embedded into an array having a larger number of pixels.

However, in the field of digital holography applied to interferometry, it is well known to that several methods can be used to reconstruct the object from the hologram. D1 teaches two examples : a Fresnel-approximation method (cf. §3) and a convolution method (cf. §4), each method having his own advantages (in particular with respect to the sizes of the "reconstruction pixel"; cf, abstract, and equations 9,16 in D1). In the particular context of the Fresnel-approximation method, **D2** teaches an alternate method that separates the reconstructed image from the noisy first order. This method involves to embed the digitized hologram into a larger matrix (cf. page 5, left column, last paragraph in D2). Applying this method with corresponding advantage to the method disclosed in D1 would then arrive at the subject matter of claim 1.

Therefore, a straightforward way exists to derive the subject matter of claim 1 from the combined disclosure of D1 and D2 and so, claim 1 lacks an inventive step.

Remark : D1 teaches in §4 to embed the digitized hologram into a larger zero matrix (see also Figs. 5,6) to perform a scaling function, however, the disclosed method applies to holograms processed by the convolution approach, and it is considered that this teaching cannot obviously be applied/transferred to the Fresnel transform approach (D1 makes it clear that the Fresnel approach leads to sizes dependency of the reconstructed objects; see abstract).

- 2.3 The features hereafter listed are also disclosed in **D1** or **D2**, therefore the corresponding dependent claims also lack an inventive step:-
- * claim 2 : the constant values are zeros (cf. last line left column, page 5 in D2);
 - * claims 3,5 : the values are arranged externally and in a non symmetrical way (cf. page 5, left column, last paragraph);
 - * claim 7,8 : the added features are inherent properties of the Fresnel transform;
 - * claims 12,13,14 : the existence of a computer means is implicit in D1.

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- 3.1 Claim 6 adds that the number of pixels of the larger matrix is inversely proportional to the desired reconstruction pixel sizes. This additional feature allows to monitor the scaling of the reconstructed object, thereby achieving a reconstructed object whose sizes can be made independent of the reconstruction wavelength and distance. This problem and related solution is not addressed in the prior art to hand such that claim 6 fulfils the requirements of novelty and inventive step (Articles 33(2) and 33(3) PCT).

- 3.2 The features added in claims 4,9-11 are not rendered obvious by the available prior art. These claims fulfil therefore also the requirements of novelty and inventive step (Articles 33(2) and 33(3) PCT).

-
4. The industrial applicability (Article 33(4) PCT) is clearly present for the subject matter of all the claims.

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5. The attention of the applicant is drawn to the fact that the application may not be amended in such a way that it contains subject-matter which extends beyond the

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International application No.

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content of the application as filed (Article 34 PCT), and that the description should be in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

The applicant is requested to clearly identify the amendments carried out and to indicate the passages of the application as filed on which these amendments are based. (these indications could be submitted in handwritten form on a copy of the relevant parts of the application as filed).

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